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G. B. AIRY, Esq., Vice-President, in the Chair.

On Personal Equation. By Professor Mitchel.

(*Letter to the Astronomer Royal.*)

At the meeting of the American Association of 1856, I announced the fact that I had contrived a simple apparatus for the investigation of the subject of "*absolute* personal equation." Sickness in my family, and other causes, have combined to prevent a full investigation of this subject until the beginning of the present year.

In case a star could be made to record the moment of its own transit, the difference between the star's record and that of any observer would be the observer's *absolute* personal equation, or what I shall term hereafter, the "personality of the eye." In like manner, in case a sound could be made to record the moment of its occurrence, the difference between the record and that of an observer would give what I term "absolute personality of the ear." The same of the sense of touch, which, as a matter of physiological curiosity, has somewhat engaged my attention.

As the stars cannot at present be made to record their own transits, I have substituted what I call "artificial stars," moving uniformly with a velocity somewhat greater than that of an equatoreal star observed with a power of 200, the power of the eye-piece now used in the transit telescope. By means of an electro-magnet, these artificial stars (ten in number) attached to my revolving disk, are made to record the exact moment at which they transit an artificial meridian line. The observer, by the aid of another magnet, records the moment of his observed transit, and the difference of these two records corrected for difference of armature and gross time of the two magnets, gives me the "absolute personality of eye."

This same quantity has been obtained also from a record of the moment at which the eye perceives a white "stripe" on a

dark ground, thrown into view by the sudden action of the electro-magnetic armature, which records the moment of transit of the artificial stars. These quantities, as will be seen hereafter, are almost identical.

To obtain "absolute personality of the ear," the observer, with his magnetic key, attempts to record the moment he perceives the sound produced by the fall of the "time-pen" on the disk, as driven by the armature of the time electro-magnet, it falls, and makes its "true" dot. The interval between the dot struck by the time-pen and that struck by the observer's recording pen, corrected for value of armature time of the observing-pen, gives the time required for the ear to execute its office, and for the nerves obedient to the will to execute the record. A like process, which it is quite unnecessary to describe, gives "personality of touch."

To the practical astronomer the personality of eye and ear are alone important; to those who have adopted the American method of transits, the "personality of the eye" remains as the quantity whose value and variations it is required to determine.

Our regular observations have been continued daily, with few exceptions, through some 60 or 70 days, my assistant, Mr. H. Twitchell, and myself making an equal number of observations to determine the following quantities,—

1. Absolute personality of eye.
2. Absolute personality of ear.
3. Observed moment of transit.
4. Observed moment of emersion.
5. Observed moment of immersion.

These constitute the regular observations. Besides these, I have obtained the "eye and ear personality" of about thirty persons (not observers) of each sex, and of ages from fourteen to seventy-five years. Among these individuals I find thus far no law which seems to govern the personality. The range is small, as the personality of eye varies between the lowest limit 137 thousandths of a second, and the highest limit 214 thousandths of one second of time. The personality of ear has for its least amount 137 thousandths of a second, and for its greatest limit, 223 thousandths of one second of time; and each of these limits belongs to the same two observers.

The mean personality of my own eye, as obtained from 255 observations, is 161 thousandths of a second. The mean personality of my ear, as obtained from an equal number of measures, is 164 thousandths of a second. These same quantities for Mr. Twitchell, as given by the same number of observations on the same days with my own, are for the eye, 144, and for the ear, 153, thousandths of one second of time.

My minimum "eye personality" is 139 thousandths of a second, the maximum reaches to 191 thousandths. My minimum

"ear personality" is 143, my maximum "ear personality" is 193, thousandths of one second of time. The same quantities for Mr. Twitchell are for

	s		s
The eye, minimum ..	0·118	maximum ..	0·184
ear ,, ..	0·129	,, ..	0·201

Having reached the above results, I was now curious to learn whether the eye and ear were steady for very short periods of time. For this purpose my assistant and myself each made five series of ten observations, each on alternate minutes, which being continued several days, showed that we were liable to a variation of "eye personality" amounting to about two-hundredths of a second on the mean of ten observations. I also found that the difference already established between Mr. Twitchell and myself was confirmed in these observations.

I will simply remark, that the sense of touch gave results almost identical with those of the eye; and this fact being soon discovered, the observations for personality of touch were discontinued.

Thus far we have presented results obtained by the eye, in seizing an almost instantaneous movement, the sudden darting of a white line from behind a black screen.

When a comparison was instituted between the absolute and observed moments of transits of the artificial stars, I found, much to my surprise, that both my assistant and myself largely *anticipated* the true time; and that in every instance, without one exception, the same fact was noticed in other persons, who were ignorant of what they were doing, while recording their transits.

After learning the fact of this unconscious anticipation, efforts were made to cure the evil by special attention. To some extent this was done, but the tendency was to an immediate relapse the moment special attention was discontinued. I find (on a mean of ten observations) my own anticipations amounting to the tenth of a second of time in more than one instance, while Mr. Twitchell's error is nearly as large. The variations from day to day, and from observation to observation in the same set, were far larger than I had anticipated.

This gave rise to the observation of "emersions" of the artificial stars from behind a dark screen. Here I found a steadiness in the results precisely equal to the performance of the eye as already determined, which for my assistant and myself seems to be the highest limit of attainable accuracy.

The experiments of observed immersion exhibited the fact of a strong tendency to anticipation, and a less degree of steadiness in the work.

I now became anxious to apply the discoveries thus made in some practical manner to our star transits.

For this purpose I have constructed a diaphragm, consisting of eight occulting bars, four on each side of a central spider's line.

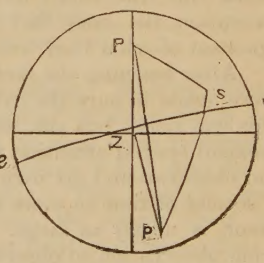
We observe the emersion from the first bar, both immersion and emersion from the second, third, and fourth bars, the transit of the central wire, the immersion and emersion of the fifth, sixth, and seventh bars, and the immersion on the eighth bar; in this way we make fifteen observations. These bars are about two seconds of time in width, and their intervals about four seconds at the equator. By observing emersion and immersion, we hope to avoid any error arising from stars of different magnitudes, as the larger stars will emerge sooner and disappear later, a mean of the two observations giving us the place of an imaginary wire between the two bars correctly. I can only say that we have had but two nights' work with the new method. The results are highly promising, but too inconsiderable to communicate.

Cincinnati Observatory, May 16, 1858.

Note relative to the Determination of Latitude with a Transit Instrument. By Captain A. R. Clarke, R.E.

In the last volume of the *Memoirs* of the Royal Astronomical Society is a very useful paper on the determination of latitude by means of a transit instrument placed in the prime vertical. In reading it over, it appeared to me that the coefficient of the collimation error there given was less simple than that which I had adopted for my own use. The subsidiary angle χ, used in the value of a', is, in truth, unnecessary.

This may be shown as follows:— Let, in the adjoining figure, P be the pole, Z the zenith, p the point in which the axis of the transit meets the heavens, being the pole of the plane $e\ w$ of the instrument's rotation, s the place of a star when observed, being distant from the great circle $e\ w$ by the amount of the collimation error c, so that $p\ s = 90 + c$. Let $\mathrm{Z\,P}\ p = \tau$, $\mathrm{P\,Z} = \varphi$, $\mathrm{P}\ p = 90 + \varphi - \gamma$.



Then the triangle P s p gives the value of $\cos p\ s$, equal to

$$-\sin c = -\cos\pi \sin(\varphi - \gamma) + \sin\pi \cos(\varphi\,\gamma) \cos(h - \tau)$$

where h is the difference between time of observation and the star's right ascension, or the angle Z P S. This equation is equivalent to

$$\tan(\varphi - \gamma) = \tan\pi \cos(h - \tau) + \frac{\sin c}{\cos(\varphi - \gamma)\cos\pi}$$

which is an exact expression for the colatitude, however large the errors of instrumental adjustment γ, t, c. If we suppose them to be very small, the equation becomes

$$\tan(\varphi - \gamma) = \tan\varphi' + \tau \sin h \tan\pi + c \sec\varphi \sec\pi$$
$$\tan\varphi' = \tan\pi \cos h$$

$$\therefore \varphi = \varphi' + \gamma + \tau \sin h \tan\pi \cos^2\varphi + c \cos\varphi \sec\pi$$

Here τ is half the difference of the east and west hour-angles of any star, and γ may be assumed equal to the level indication. The relations of τ and γ to the azimuthal deviation ($180 - \mathrm{P\,Z}p = \nu$) and the level error ($90 - \mathrm{Z}p = \mu$) are the following, derived from the triangle P Z p,

$$-\sin(\varphi - \gamma) = \cos\varphi \sin\mu - \sin\varphi \cos\mu \cos\nu$$
$$\sin\tau \cos(\varphi - \gamma) = \cos\mu \sin\nu$$

which, supposing the errors of adjustment small, give $\gamma = \mu$, $\tau \cos\varphi = \nu$. As the zenith distance, z, of each star for the middle wire must generally be calculated in each case in order to find the star without loss of time, the simplest form for the equation of condition is this,—

$$\varphi = \tan^{-1}(\tan\pi \cos h) + \mu + \nu \,.\, \tan z + \xi \,.\, \sec\pi$$

when ξ is the collimation $\times \cos\varphi$.

It is important to remark that when the star is within a small number of degrees of the zenith, it will be incorrect to take the mean of the times of the passage of the star over the different wires. In this case, a table of intervals should be constructed for each star in order to reduce the time of transit over any given wire to that of the centre wire. If f be the distance of any wire from the centre wire expressed in equatoreal interval of time, h' the hour-angle of the star when on this wire, h its hour-angle when on the centre wire, then, neglecting the consideration of errors of adjustment,

$$\cos h - \cos h' = \frac{f}{\cos\varphi \cos\pi}$$

Therefore, if $\cos\varphi \cos\pi \sin h = n$, the interval required in time is

$$\frac{f}{n} - \cot h \,.\, \sin\frac{15''}{2} \,.\, \frac{f^2}{n^2}$$

Addition to a Paper "On the Mathematical Theory and Practical Defects of Clock Escapements, &c." By James Mackenzie Bloxam, Esq., being a series of posthumous notes. Communicated by G. B. Airy, Esq., Astronomer Royal.

In the XXII. Volume of the *Memoirs* of the Royal Astronomical Society is a very elaborate paper, by Mr. Bloxam, on Clock Escapements. The ingenious author of that memoir died in the

close of 1857. His attention had been engaged upon his favourite subject to the last year of his life: and he left a few notes upon his paper, and a Supplement, which I think worthy of the honour of being presented to the Society. These I subjoin, without further preface.

Page 110, line 9 from the bottom, at the word "disturbed," *insert* the following foot-note:

* If a body in angular motion meet with a resistance which does not act on the centre of gyration, the result is, not to stop the motion of the body, but to cause it to move round a new axis; unless, of course, the original axis be fixed and the body perfectly rigid. In practice the arm of the gravity escapement is not a rigid body—sometimes very far from it—and the axis of motion is not perfectly fixed, consequently, it is possible that the act of stopping the arm by contact with the pallet wheel at one point may give a sudden and not immaterial impulse to the pendulum on which the arm rests at another point. This question should be borne in mind whilst designing the form of a new arm or considering the merits of one already designed. It has not been lost sight of in designing the escapement described at the end of this paper.

Page 122, line 5, between the words "off" and "the," *insert* "the circular part of."

Page 126, line 4 from the bottom, for "$d\gamma$ rate" *read* "d_γ rate."

Page 127, line 4 from the bottom, between the words "factors" and "within" *insert* "of the three terms."

Page 136, bottom of the page, *add*, "But inequalities in the spring, or defect in the horizontal position of the chops which clip the spring, would thus have more power on the pendulum."

Page 139, line 7, before "weight" *insert* "the."

Page 141, line 9 from the bottom, *add* "Accidental experiment, of which the details are completely preserved, has fully confirmed these ideas on the injurious effects of oil on the pallets, &c., of the gravity escapement."

Page 146, line 7, effect of the change in the density of the air, *for* + 0·166 *read* + 0·222, in conformity with corrections in the final Supplement.

Page 146, line 12, to the word "pendulum" attach the following foot-note:

"I have since made comparative experiments with arcs of vibration $= 1^\circ\ 29'$ and $1^\circ\ 55'$. After deducting the estimated effect of the action of the escapement, including $\frac{1}{2}\mu$, (see § 8, art. *Rate*), in each experiment, the result was that the clock went $1^s{\cdot}24$ slower when the arc of vibration was larger. This is about half the difference of the circular errors."

Page 147, after line 9, insert the following paragraphs:

Since q is but small, it is obvious that the pressure of the arms on the pallet-wheel must increase whilst the wheel raises the arms: this is an advantage, because it will always be found that, if the pressure of the arm is constant, more force will be required to start the wheel, after it has been stationary, though for less than a second of time, than will be required to keep it in motion; and,

consequently, though there be only just sufficient power to be certain to start the wheel, yet, in many positions (perhaps in every position but one), there must be a considerable excess, which will increase the danger of driving the arm too far,* and, also, cause the escape wheel to strike the detent with greater force than it otherwise need do; whilst, on the other hand, if the pressure of the arm increases so rapidly that the wheel must have some excess of power at starting, yet the whole of its power may be employed in raising the arm, and, when the wheel reaches the detent, there need be, theoretically speaking, no excess of power; and, practically speaking, a materially smaller excess.

If the pressure of the arm on the pallet-wheel were constant, then, in case of a deficiency of power the pallet-wheel would fail to start, and the clock would stop, though not necessarily for so long a time as to be discovered unless by means of almost daily comparisons. As it is now constructed, if there happened to be a small deficiency of power, the wheel would nevertheless advance sufficiently to allow the escapement to act so far properly that it would not trip or omit to count every oscillation of the pendulum, but of course the proper action of the escapement on the pendulum would be more or less disturbed. The latter defect is likely to remain undetected for a much longer time than the former, the former is a much worse defect, but it can always be detected without difficulty *if* the clock is frequently compared with another. Of course the going weight of the clock ought to be sufficiently heavy to insure the proper action of the escapement; but it is desirable that it should not be unnecessarily heavy. Of the two the present construction admits of a smaller going-weight being used with equal safety; or, if the weight be the same, it gives greater certainty to the action of the escapement without greater ill effects. A just medium, so as to avoid both defects, would be best; but I should be inclined to err on the side of making q too small rather than too large.

I think that I have made q somewhat too small, which is partly attributable to an apprehension that it would be difficult to make the arms too light. If I were to construct a new escapement I should, perhaps, make q somewhat larger.

At the end of the Paper, attach the following Supplement:—

Long since the preceding paper was written I have made some series of experiments upon the gravity-escapement clock there described, and also upon a dead-beat clock, for the purpose, among others, of ascertaining the effects of changes of the density of the air which are independent of changes of temperature, or, what

* This is especially the case when the arm is raised by the wheel acting on inclined planes, and the friction is considerable; and it is *one* of the reasons why gravity escapements have so often failed to lock securely. Before I abandoned the use of inclined pallets I made them concave instead of plane, which made the action of the escapement materially safer.

amounts to the same thing, changes of atmospheric pressure.* These experiments were carried on in Madeira, and were continued down to May 1857, when I returned to England. Of these I can only give the following short account.

I must, however, first correct some errors in § 21 of my original paper. The mean specific gravity of the pendulum is 11·0, not 12·1. Also the factor 1·65, which I have employed for including the resistance of the air, is that given by Colonel Sabine, for a pendulum with a *flat-shaped* bob, and 2·03 is the factor given by Baily for a *cylindrical* bob, and is therefore the one which I ought to have used.† Moreover, this factor is intended for a *solid* cylinder, and in order to make it applicable to the present case we must estimate the specific gravity of the pendulum, inclusive of a space in the cylinder to which the air has access, and which, therefore, does not affect its buoyancy and is not included in the above estimate. This second estimate gives the specific gravity 10·1. The result deduced from these data is, that when the barometer stands at 30 inches, the daily rates of the clock, due to the effect of the buoyancy and of the resistance of the air, are respectively $-4^s{\cdot}8$ and $-5^s{\cdot}2$, making together $-10^s{\cdot}0$. Consequently, for an increase of the pressure of the air, corresponding to 1 inch on the barometer, the difference of the daily rate is $\frac{-1}{3}$ second.

Perhaps the above estimate requires to be a little increased, since the pendulum-bob is not of a pure cylindrical form, but this may be neglected without material error.

I believe that Sabine's and Baily's experiments were made upon pendulums swinging in very small arcs, and it has been assumed that the distance of the vibration is immaterial, which is the result of such theory as could be applied to the case. I am inclined to think, however, that the resistance of the air to a pendulum vibrating in an ordinary clock-case affects the rate of the clock more when the distance of the vibration is greater, and though by no means in the same proportion, yet very materially. If so, an addition depending upon the distance of the vibration must be made to the above estimate. I shall now proceed with the account of my own recent experiments.

A series of experiments made during the Madeira season, A.D. 1854–5, showed that the gravity escapement-clock described in my original paper went slower when the atmospheric pressure

* I have proceeded upon the above assumption, though it is not strictly correct. If $\frac{3}{4}$ths the elastic force of the aqueous vapour be deducted from the barometric prersure of the air, the remainder will give the pressure of *dry* air of equal density. Of course it is the density of the air within the clock-case that we want to measure. Now, with regard to the barometric pressuse there is no difficulty, but with regard to the humidity of the air there may be a difficulty, and the experimentalist must use his discretion.

† I have never myself examined the original accounts of Sabine's and Baily's experiments which are published in the *Philosophical Transactions*, and I was misled by another work.

increased, and *vice versâ*. The difference was one-third second per day for one inch on the barometer.* This I consider to be a fairly well ascertained and correct result.

During the season 1855–6, I made experiments with a large addition to the weight of the arms of the escapement, so that the arc of vibration of the pendulum was increased from 90′ to 115′ on each side of zero. The compensation of the pendulum for temperature proved to be now so deficient that it was necessary to correct it, and I added $1\frac{1}{4}$ lb. of mercury, which was as much as the cylinder could properly contain. The time thus lost, and other untoward circumstances, rendered the experiments for this season of no further use.

During the season 1856–7, I continued the experiments with the weighted arms, and it appears that, notwithstanding the increased specific gravity of the pendulum, the clock is now more influenced by changes in the pressure of the air than it was before the above-mentioned alterations were made, though the escapement must have greater effect in neutralising that influence, if I may assume that the larger arc of vibration does not vary less with equal changes in the pressure of the air. The compensation for temperature is still insufficient, but not so much so as to render the experiment nugatory. Indeed these are very satisfactory in one respect, namely, that during a trial of 156 days, the observed errors of the clock agree with the errors estimated by the mean rate corrected for temperature and pressure to less than $\frac{1}{4}$th of a second throughout, which does not exceed the limits of the errors of the observation, considering that the pressure and temperature of the air are involved. But the observed errors do not always occur at sufficiently short intervals, and, consequently, some valuable opportunities for ascertaining the effect of changes of pressure were lost, and the ultimate result is deduced from a smaller number of changes than I could desire. The result which I have adopted is, that with the heavy arms a change of atmospheric pressure equal to one inch on the barometer alters the rate of the clock $\frac{3}{8}$ths of a second per day. Hence it appears, that nothing is gained by increasing the arc of vibration; but it must not be inferred that nothing would be gained by diminishing the quantity, and if there were room for such an alteration: but in my clock that is already a small quantity, and I should deem it unadvisable to make it smaller—at all events, without making the arms longer, which would involve a greater alteration than it is worth while to make in the present clock.

The distance of the vibration of the pendulum varied so little that I have failed in my attempt to estimate the effect produced by change of atmospheric pressure, which effect is, I suspect, much less than I have estimated it in my original paper.

Though my gravity escapement-clock proves to be in its pre-

* The barometer was a good one, and the proper corrections were applied for reducing the readings to the standard for temperature 32°.

sent form far from perfect as regards the compensation for changes in the pressure of the air, yet that compensation is partly effected whilst the dead-beat escapement increases that source of error. With the arms of their original weight, my clock is, I think, a very good one, notwithstanding it is mounted on a wooden case, which, of course, it ought not to be.

The clock with the dead-beat escapement was manifestly greatly effected by changes of atmospheric pressure — I should say three or four times as much as the other clock; but the anomalies were so great, that it is impossible to eliminate the effect of any one small disturbing cause with tolerable accuracy. This is all consistent with what I have written in my original paper: see § 18, and the last sentence of § 21. The escapement of this clock is jewelled, but the train is not a fine one, which, it must be admitted, detracts from the value of the experiments.

To sum up, it appears to be the result of theory and experiment, that the dead-beat diminishes the errors of the uncompensated pendulum, which arise from changes of temperature, but increases the errors which arise from changes of the pressure of the air. On the other hand, the gravity-escapement increases the errors of the uncompensated pendulum which arise from changes of temperature, and diminishes the errors which arise from changes of the pressure of the air. With both escapements the temperature compensation of the pendulum is necessary, and the difference in the quantity is of little importance. As regards the errors for pressure, the gravity escapement of the form, described in my original paper, is far superior to the dead-beat. Probably it would be difficult to make the gravity escapement so as to furnish a complete pressure compensation; but if the temperature compensation be good, the variation of the rate of the clock may be ascertained by consulting the barometer. By means of an additional pair of arms a sufficient pressure compensation might perhaps be added to a pendulum with either escapement; but the mechanical imperfections of the dead-beat seem to preclude the possibility of obtaining from it any very accurate results. The proposed arms would be quite independent of the escapement, and each arm should swing with the pendulum from zero to the end of the vibration, and back again to zero.

When there is room for choice, there is an obvious advantage in making the pendulum-bob with a material of the greatest possible specific gravity.

It should be borne in mind, that Sabine's and Baily's experiments were made with pendulums vibrating in small circular arcs, and mine with pendulums suspended by springs and with mercury in the cylindrical bobs. The curve formed by the spring, as well as its elasticity, must affect the vibration of the pendulum, and so also must the oscillation of the mercury in the cylinder, though it be but small.

Ventnor, Isle of Wight, August 1857.

Discovery of a Comet (*Comet V.*, 1858.)

By Dr. Donati.

(*Communicated by S. M. Drach, Esq.*)

On the 2d of June at 10^h P.M. Dr. Donati discovered a comet in the constellation *Leo*, of which he obtained the following approximate position:

R.A.	Decl.
h m s	° ′
9 24 35	+ 23 55

The observations underneath were subsequently made by him.

1858.	Florence M.T.	Comet—Star. R.A.	Comet—Star. Decl.	No. of Obs.	App. R.A. of Comet.	App. Decl. of Comet.
	h m s	m s	′ ″		h m s	° ′ ″
June 7	10 27 5	− 0 54·84	+ 16 42·3	2 with *a*	9 24 59·33	+24 21 58·6
8	9 37 57	−12 46·18	+ 2 14·4	2 — *b*	25 2·40	27 40·7
9	10 52 1	−12 43·27	+ 9 10·2	2 — *b*	25 5·31	34 36·5
10	9 57 54	−12 38·95	+ 15 32·0	1 — *b*	25 9·63	40 58·3
11	10 25 41	+13 39·55	−13 30·6	2 — *c*	25 15·84	47 38·4
12	10 35 2	+13 44·77	− 7 9·1	2 — *c*	9 25 21·06	+24 53 59·9

Mean Places of Comparison Stars for 1858·0.

	R.A.	Decl.	
	h m s	° ′ ″	
a	9 25 52·76	+24 5 13·0	Lal. 18775
b	37 47·20	24 25 23·9	ε Leonis B.A.C. 3331
c	9 11 35·09	+25 1 5·5	Lal. 18355

The Comet is very faint.

The Elements and Ephemeris of this Comet will be found on the following page.

Elements of Calypso (*Planet* ⑱). By M. Oeltzen.

Mean Equinox 1858·0

Epoch 1858, April 9·42561

		° ′ ″
M	=	35 56 59·1
π	=	78 38 28·0
☊	=	152 9 45·9
i	=	6 34 23·4
φ	=	37 3 3·9
μ	=	519·946
Log a	=	0·556032

These elements are calculated from a Bilk observation of April 4, a Berlin observation of April 9, and a Vienna observation of April 16.

Elements and Ephemeris of Comet V. 1858.

By Dr. Bruhns.

1858, Sept. 5·80037, Berlin M.T.

π = 26° 20′ 16″·7
Ω = 166 32 50·2
} Apparent Equinox June 16.
i = 72 23 59·7
Log q = 9·543068

Motion retrograde.

Ephemeris for 0^h, Berlin M.T.

1858.	R.A. ° ′	Decl. ° ′	Log Δ.
June 3	141 17·4	+ 23 52·2	0·3469
7	141 14·8	24 19·4	0·3483
11	141 17·8	24 44·7	0·3491
15	141 26·3	24 9·0	0·3492
19	141 39·7	25 32·7	0·3484
23	141 58·0	25 56·0	0·3468
27	142 21·0	26 18·4	0·3444
July 1	142 28·4	26 40·9	0·3410
5	143 20·0	27 3·3	0·3365
9	143 55·8	27 26·2	0·3309
13	144 35·9	27 49·6	0·3239
17	145 20·0	28 13·6	0·3155
21	146 8·1	28 38·7	0·3057
25	147 0·4	29 5·0	0·2942
29	147 57·0	20 32·8	0·2805
Aug. 2	148 58·3	30 2·0	0·2646
14	152 36·0	31 36·0	0·1978
26	157 48·1	32 4·3	0·0840
Sept. 7	166 17·7	+ 20 54·6	9·8664
19	180 48·0	− 23 31·5	9·8034
Oct. 1	189 24·5	− 48 4·4	9·9695

On the Annular Solar Eclipse of 1858, *May* 14–15, *as observed at Greenwich, Bedford, Great Harrowden, Wellingborough, and Market Harborough, under the Authority of the Astronomer Royal.*

On account of the importance and rarity of the phenomenon of an annular eclipse observable over so great a portion of England, the Astronomer Royal had, previously to its occurrence, devoted considerable attention to the nature of the observations which it seemed desirable to make, and to the selection of suitable observing stations across the line of the central phase. Ample arrangements were made for observing the phenomena of the eclipse at Bedford and Market Harborough lying nearly at the same distance on opposite sides of the central line, and at the village of Great Harrowden, two miles from Wellingborough, which was very nearly upon the line.

The observing parties for Market Harborough and Bedford were provided by the Rev. George Fisher and John Riddle, Esq. respectively, while the Astronomer Royal himself, accompanied by Mr. Main, proceeded to Great Harrowden Station. Mr. G. Dunkin was appointed to make observations at Greenwich.

These were the general arrangements made, but they were almost altogether frustrated by the unfavourable state of the weather. It will be sufficient, therefore, under the actual circumstances, to notice without any details, the observations which it was found practicable to make at the different stations.

Greenwich.

Mr. Dunkin observes that the sun was visible during the morning till within five minutes before the first contact. Clouds then covered the disk till after the middle of the eclipse, when it became faintly visible through the clouds for about ten minutes. With the North Equatoreal eight measures of difference of N.P.D. of cusps were observed; with the East Equatoreal three single measures were made of breadth of lune by the use of the double-image micrometer; and with the altazimuth an azimuth of the moon's first limb was observed. All the observations were made with great difficulty.

With regard to general phenomena, Mr. Dunkin remarks:—"At the exact instant of contact the sun was obscured; in less than a minute he again appeared, and the moon had then advanced considerably on the disk, the limb looking clearly defined, and without any irregularities. Clouds immediately covered the sun, and from this time, excepting only a few occasional glimpses, nothing more was seen till after the greatest obscuration."

The following photometric observations were taken by Mr. E. J. Hallam:—

Hour, Minute, and Second of Exposure.	Number of Seconds when it became Tinted.	How long Exposed.	Clouds.
d h m s		m s	
March 15 23 46 50	35	5 10	9
52 13	64	5 47	10
58 8	76	5 52	10
16 0 4 0	80	5 0	9
9 20	90	5 0	10
14 25	45	5 0	10
19 30	70	5 0	10
25 0	83	6 0	19
31 0	95	5 0	10
36 0	70	5 0	10
41 0	110	5 0	10
46 0	600*	11 0	9
1 0 0	480*	10 0	10
10 0	200	5 0	9
15 0	30	5 0	10
20 0	120	5 0	10
25 0	230	5 0	10
30 0	180	5 0	10
35 0	240	5 0	10
40 0	145	5 0	10
45 0	90	5 0	10
50 0	140	5 0	10
55 0	103	5 0	10
2 0 0	15	5 0	10

Remarks.

At $0^h\ 2^m\ 52^s$ I first saw the sun eclipsed; afterwards I saw it occasionally through the clouds till $0^h\ 37^m$, when rather more than half of it was covered. I did not see it again till $1^h\ 1^m$. I occasionally saw it afterwards through the clouds.

During the eclipse there appeared a great deal of fog and mist about the ground, which gradually disappeared as it advanced. There appeared to be no effect on birds — they were singing just as ordinarily.

When the sun was nearly totally eclipsed, the sky had the appearance of an approaching storm.

When the eclipse commenced, the wind became very calm. Previously it had been blowing a heavy gale from the W. and N.W.

At $1^h\ 50^m$ a few drops of rain fell, and occasionally fell afterwards till 2·15.

* The photographic paper at this time was not affected in the slightest degree for several minutes.

Bedford.

Mr. Riddle was stationed in the grounds of the house of Mr. Blower, a gentleman who kindly gave to him and his party the most hospitable reception during their stay, and insisted on their taking up their quarters at his house. He remarks that clouds began to gather before ten o'clock, and at the time of first contact the sun was quite invisible. Soon after this there was a momentary glimpse of the sun, showing the moon considerably advanced upon the disk, and at intervals a few similar glimpses occurred which enabled him and the lads assisting him to take on the whole sixteen measures of the distance of the cusps.

Market Harborough.

Mr. Fisher scarcely saw the sun during the whole time of the eclipse, and obtained only one measure of the distance of cusps.

Great Harrowden.

Till ten o'clock the sky was beautifully clear at Wellingborough; but, before the observing party started for Great Harrowden, clouds were rapidly collecting, and, on arriving on the ground, the sun was only sufficiently visible for a few instants as to enable the telescopes to be put into focus. The clouds still continued to thicken, and after some time rain began to fall, and continued gently during the whole of the continuance of the eclipse.

The only phenomena observable were, therefore, those relating to the darkness produced by the eclipse, and nothing was observed differing materially from what was noticed by the greater number of the observers whose accounts are already circulated in the *Notices*. The closing in of the clouds, and the dull uniform leaden hue which they exhibited, the rapid increase of darkness near the time of greatest obscuration, and the apparent pulsations by which it was accompanied, the still more startling phenomenon of the instantaneous return of a great portion of the light on the breaking up of the annulus were observed, and of themselves amply repaid those present for the trouble which had been taken. The effect on the rooks, which, before the commencement of the eclipse, had gone into the neighbouring fields to feed, was very remarkable. For several minutes before the time of greatest obscuration they returned to the rookery in groups, and after considerable clamour of cawing were seen to turn into their nests; but, on the light reappearing, they came out in a body, and flew off clamorously into the fields again.

The Astronomer Royal desires, in conclusion, to express his warm thanks to all the gentlemen who so liberally came forward in various ways to give assistance in furthering the objects of the

expedition. To Mr. Fisher, for putting himself and the resources of the Naval School at his disposal; to Mr. Blower, of Bedford, who exhibited such generous hospitality to Mr. Riddle and his party; and, finally, to Mr. Simpson, of Great Harrowden, to whom his obligations are still more personal, for the warm interest which he took in the matter, which induced him not only to provide every facility for observing in the grounds of Rockingham House, but to entertain himself and his friends with a cordial hospitality which will always be remembered by the whole party with pleasure and grateful feelings.

Occultation of Regulus, May 19, 1858, *observed at Crumpsall Hall Observatory, near Manchester.*

By Thomas Worthington, Esq.

Telescope employed, achromatic equatoreal, 5 inches' aperture, and 70 inches' focal length, with a power of 68 adjusted on the star.

	h	m	s	
Disappearance	12	50	41·4	Sidereal Time.
Reappearance	13	19	50·9	

Disappearance and reappearance both instantaneous, without any projection of the star on the moon, or other phenomenon.

By Joseph Baxendell, Esq.

Newtonian equatoreal, 13 inches' aperture, and 9 feet focal length, with a power of 81 adjusted on *Regulus*.

	h	m	s	
Disappearance	12	50	41·6	Sidereal Time.
Reappearance	13	19	51·2	

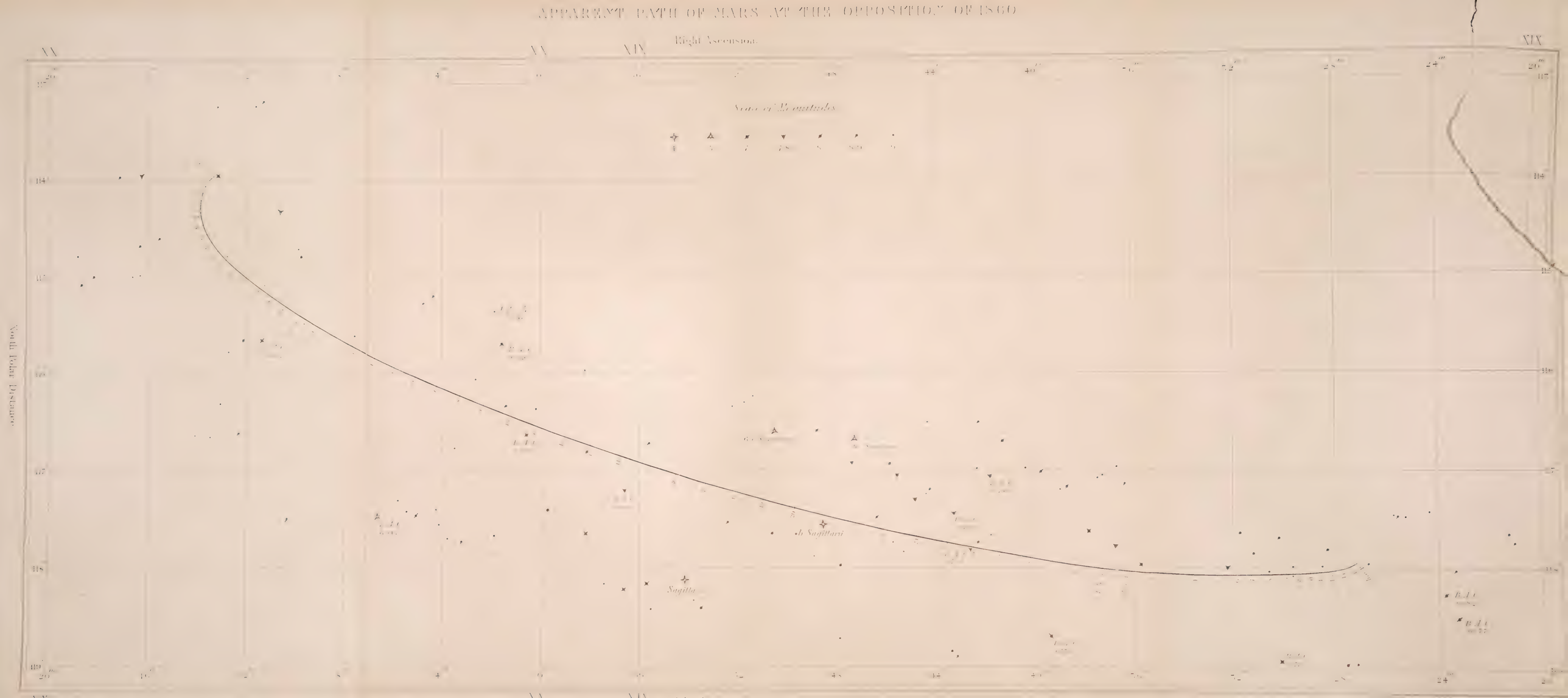
Disappearance instantaneous. At the reappearance rather more than half the disk of the star was projected instantaneously from behind the limb of the moon; but about three-quarters of a second elapsed before the whole of the disk became visible. The moon's limb, though rather tremulous, was very well defined, and a projecting mountain at a little distance north preceding the point of emersion was very conspicuous.

The disappearance, at the dark limb of the moon, of the star No. 865 of the Greenwich Twelve-year Catalogue, 9th magnitude, was observed by Mr. Worthington at $12^h\ 43^m\ 47^s{\cdot}6$; and by Mr. Baxendell at $12^h\ 43^m\ 47^s{\cdot}4$, and appeared to both observers to occur instantaneously.

At the reappearance of *Regulus* at the bright limb of the moon the light of the star contrasted strongly in brilliancy and whiteness with that of the moon.

Manchester, June 10, 1858.

APPARENT PATH OF MARS AT THE OPPOSITION OF 1860



On the Reduction of Occultations. By Capt. A. R. Clarke, R.E.

"Among the different methods made use of for the determination of terrestrial longitude, that of observing the exact instants of contact of the moon's limb with known stars is one of the most accurate. Various forms have been proposed and adopted for the calculation of the longitude from the observed time of occultation, many of them, in order to save computation, a little deficient in point of accuracy. It seems a pity, however, not to take every advantage of an observation that can be made to such nicety as the disappearance of a star at the dark limb of the moon under favourable circumstances. And in order to make use of the observation to the greatest advantage, the longitude should not only be obtained by some exact method, but we should also be able to assign the effect of any error in the assumed places of the moon and star, and the other data of the calculation. We have here to deal with eleven quantities, the semiaxes of the terrestrial spheroid, the latitude and longitude of the observer; the position of the moon, which involves three quantities, and the linear radius of her surface assumed spherical; also the direction of the star, involving two quantities, and finally the time of observation. If we take the equatoreal radius of the earth as the unit of length, there will remain ten sources of error with which every observed occultation is affected. The object of this paper is to exhibit an exact and compact method of computing the effects of these different sources of error."

Instructions and Chart for Observations of Mars in Right Ascension at the Opposition of 1860, *for obtaining the Measure of the Sun's Distance.* By the Astronomer Royal.

In a lecture to the Royal Astronomical Society on 1857, April 8, the Astronomer Royal discussed the principal methods available for correcting the measure of the sun's distance, and insisted on the advantages inherent in the method of observing the displacement of *Mars* in right ascension when he is far east of the meridian and far west of the meridian, as seen at a single observatory. After indicating the oppositions of the years 1860, 1862, 1877, as particularly favourable for this purpose, he continued his remarks nearly in the following terms:—

"In order to compare the value of this method with that of observations on the meridian at two observatories, we must estimate the length of the base-line. The greatest meridional base-line, from Pulkowa to the Cape of Good Hope, is = Earth's radius × 2 sine 47° nearly. The measure of the greatest base-line, in the method now recommended, depends on the latitude of the observatory. At Greenwich it is = Earth's radius × 2 sine 38° 30′; at the Cape of Good Hope and at St. Jago (Chili) it is

about = Earth's radius × 2 sine 57°; at Madras it is nearly = Earth's radius × 2 sine 77°. Thus it appears that at each of the three last-mentioned observatories, the base-line which can be obtained is considerably greater than the best which can be obtained by meridional combination of two observatories. At Madras, the angle to be measured would be about 44″. To this is to be added that the method is attended with no expense whatever; that the observations, which are compared, are made with the same telescope and by the same observer, or the same series of observers; that there is none of the tediousness, the wearying correspondence, or the doubt, which are inseparable from observations requiring distant co-operation; and that the observer is supported by the feeling that his own unassisted observations will give a perfect system of means for deciding one of the most important questions in astronomy. The Astronomer Royal expressed his opinion that this method is the best of all.

"In order to use the process to the greatest advantage, *Mars* ought to be visible at six hours' distance from the meridian on each side; and therefore his declination ought to have the same name as the latitude of the observatory. Thus, 1860 will be a favourable year for the Cape of Good Hope and St. Jago; 1862 will be favourable for North American and European observatories. It is scarcely necessary to discriminate between them for Madras, where both years are good; 1862, however, is preferable to 1860.

"The first equipment for this observation, on the necessity for which special stress must be laid, is an equatoreal, firm in right ascension. Many modern equatoreals are deficient in this important quality. It would be well, in using them, to apply a temporary mechanism for fixing the instrument in right ascension, such as its construction may permit. The next, which will be found advantageous, though not strictly necessary, is the apparatus for the American or chronographic method of transits, by which the number of observations may be greatly increased, and something will be gained in the accuracy of each. These, with the ordinary clocks and chronometers, &c., of an observatory, are all that are required.

"The principal rules for the observer would be: To make the observations as near as practicable to the six-hour intervals from the meridian, on both sides; and to repeat the observations in continued sequence morning and evening, morning and evening. If different observers are employed, to take care that each observer is charged as often with morning as with evening observations. To determine the difference between the right ascension of *Mars* and the right ascensions of two stars, one having greater N.P.D., and the other smaller N.P.D. than *Mars*. To use the same stars in at least two observations of different names, morning and evening; and in as many more consecutive observations as can be conveniently arranged. When it becomes necessary to change the selection of stars, to observe both the old pair and the new pair in

one morning or evening observation. In all cases to observe, by such alternation as is most agreeable to the observer, both limbs of *Mars* (the preceding and the following). The observations might with advantage commence a fortnight before opposition and terminate a fortnight after it.

"In the nature of external preparation, applying generally to all observatories, the principal requisite is a chart of the apparent path of *Mars*, in considerable detail, giving the place of the planet for every hour, or every few hours, and giving the places of all the stars, little and great, in its neighbourhood. The observer in possession of this will be able to select stars of such a magnitude as he judges most agreeable to his eye, and at such intervals as will be convenient for his system of wires; and to attend rigorously to the condition of always comparing the planet with two stars, one of greater and one of less N.P.D. It might be proper that the colour of the stars should be noted, in order that, to avoid possible inequalities of refraction, stars of the same colour as *Mars* (if there are such) may be selected.

"On reviewing the whole subject, the Astronomer Royal presses on the attention of astronomers the importance of observing *Mars* in 1860 and 1862; and for this purpose, the necessity of speedily making the preparations, instrumental and literary, which he has described, especially that of the charts of stars with the path of *Mars*."

With the view of giving facilities to astronomers who may be willing to take a part in this enterprise, Mr. Main, at the request of the Council of the Society and the Astronomer Royal, has prepared a Chart of the Path of *Mars* near the Opposition of 1860, and of the principal stars down to the ninth magnitude in the neighbourhood of the path. This Chart has been engraved at the expense of the Society, and is now presented to the astronomical public. The places of the planet are taken from the *Nautical Almanac*. The places of the stars are taken from Argelander's Zones. (A catalogue of the places, roughly reduced to the year 1860, is subjoined.) This list will perhaps suffice for the greater number of observers. But it cannot be too strongly urged that the operations at each observatory are totally independent of those at every other observatory; and those observers, who, from the magnitude of the instruments at their command, or from other circumstances, are desirous of using smaller stars, are recommended to construct their own catalogues or charts.

For reducing the observations which may be obtained, it is to be remarked that the effect of parallax in right ascension in seconds of time is—

$$\frac{\text{Sun's mean parallax in seconds of arc}}{15 \times \text{distance of } \textit{Mars}} \times \frac{\text{cosine latitude of observatory} \times \text{sine hour-angle}}{\text{cosine declination of } \textit{Mars}}$$

The elements required for the reductions will be found in the *Nautical Almanac*.

Catalogue of Stars near the Path of Mars at the Opposition in 1860.

(*Extracted from Argelander's Zones.*)

Page.	Zone.	No.	Name of Star.	Mag.	R.A.	N.P.D.
					h m s	° ′
71	241	22	....	8.9	19 21 7	117 43
71	241	23	....	8.9	19 21 19	117 38
71	241	26	....	8.9	19 23 30	118 2
71	241	24	B.A.C. 6677	8	19 23 18	118 30
71	241	25	B.A.C. 6682	8	19 23 55	118 17
71	241	27	....	9	19 24 23	117 25
398	394	24	....	9	19 25 16	117 27
398	394	25	....	8.9	19 25 44	117 26
398	394	26	....	9	19 25 52	117 27
398	394	27	....	9	19 26 50	117 55
71	241	31	....	8.9	19 27 17	118 58
71	241	32	....	8	19 27 39	118 58
398	394	28	....	8	19 28 16	117 48
398	394	29	....	9	19 28 26	117 58
398	394	31	....	9	19 29 42	118 5
398	394	30	....	9	19 29 49	117 58
398	394	33	B.A.C. 6716	7	19 30 10	118 54
71	241	34	....	8.9	19 30 16	117 41
398	394	32	....	9	19 30 35	118 1
398	394	34	....	8.9	19 31 18	117 50
71	241	37	....	8.9	19 31 51	117 37
398	394	35	....	7.8	19 32 7	118 0
399	394	38	....	7	19 35 40	117 57
399	394	40	....	8.9	19 36 15	117 8
399	394	41	....	9	19 36 30	116 56
399	394	39	....	7.8	19 36 35	117 43
399	394	42	....	9	19 37 10	117 3
399	394	43	....	9	19 37 20	117 6
71	241	41	....	7	19 37 40	117 36
399	394	44	....	8	19 38 45	117 10
399	394	45	....	9	19 38 52	117 11
			B.A.C. 6770	7	19 39 23	118 41
399	394	46	....	8	19 39 43	117 0
399	394	47	....	9	19 40 16	116 58

Page.	Zone.	No.	Name of Star.	Mag.	R.A.	N.P.D.
					h m s	° ′
399	394	48	....	8	19 41 21	116 43
399	394	49	B.A.C. 6786	7.8	19 41 45	117 3
71	241	46	....	9	19 41 51	117 38
67	239	72	....	8.9	19 42 8	116 31
71	241	47	....	8.9	19 42 8	117 42
399	394	50	....	9	19 42 20	116 59
71	241	48	B.A.C. 6792	7.8	19 42 31	117 49
399	394	51	B.A.C. 6795	7.8	19 43 7	117 26
71	241	49	....	8.9	19 43 7	118 54
71	241	50	....	8.9	19 43 16	118 51
399	394	52	....	8.9	19 44 7	117 12
399	394	53	....	9	19 44 11	117 15
67	239	74	....	9	19 44 13	116 32
399	394	54	....	7.8	19 44 48	117 18
71	241	51	....	9	19 45 22	117 51
67	239	77	....	7.8	19 45 35	117 3
399	394	56	....	9	19 45 53	117 43
67	239	78	....	8	19 45 50	116 56
399	394	55	....	8.9	19 46 30	117 28
67	239	80	ω Sagittarii	5	19 47 16	116 40
67	239	79	....	7.8	19 47 18	116 55
399	394	57	....	8	19 47 57	117 58
399	394	59	δ Sagittarii	4	19 48 19	117 32
67	239	81	....	8	19 48 43	116 35
399	394	58	....	9	19 48 57	117 53
399	394	60	....	9	19 49 34	117 37
399	394	62	60 Sagittarii	5	19 50 24	116 35
399	394	61	....	8	19 50 32	117 37
67	239	88	....	9	19 51 24	116 14
67	239	89	....	9	19 51 54	116 17
67	239	90	....	9	19 52 8	116 19
399	394	63	....	8.9	19 52 16	117 33
399	394	64	....	8	19 53 27	118 22
399	394	65	....	9	19 53 52	118 20
399	394	66	ϵ Sagittarii	4	19 54 2	118 5
399	394	67	....	9	19 55 30	118 24
67	239	92	....	8.9	19 55 46	116 43
399	394	69	....	7	19 55 48	118 8
71	241	59	B.A.C. 6888	7.8	19 56 39	117 13

Page.	Zone.	No.	Name of Star.	Mag.	R.A.	N.P.D.
					h m s	° ′
399	394	70	....	7	19 56 40	118 12
399	394	71	....	9	19 57 29	118 10
67	239	95	....	8.9	19 58 8	115 58
67	239	96	....	8	19 58 15	116 50
399	394	73	....	7	19 58 20	117 37
399	394	74	....	8	19 59 52	117 25
68	239	99	....	9	20 0 22	116 20
399	394	75	B.A.C. 6906	7	20 0 34	116 38
68	239	100	....	8.9	20 1 32	116 17
			B.A.C. 6920	7	20 1 40	115 41
399	394	76	....	9	20 1 52	117 39
			Lalande 38517	9	20 2 0	115 20
68	239	101	....	9	20 2 43	116 5
399	394	77	....	8.9	20 3 0	117 44
68	239	102	....	9	20 3 33	116 46
399	394	78	....	9	20 3 53	117 40
399	394	79	....	9	20 4 8	117 34
399	394	80	....	9	20 4 19	117 24
68	239	103	....	8.9	20 4 23	115 13
68	239	104	....	8.9	20 4 44	115 17
399	394	81	....	8	20 5 5	117 28
399	394	82	....	9	20 5 36	117 26
399	394	83	....	9	20 5 55	117 18
399	394	84	B.A.C. 6947	5	20 6 31	117 27
68	239	105	....	9	20 7 46	115 38
68	239	106	....	9	20 9 45	115 27
68	239	107	....	8.9	20 9 45	114 48
68	239	108	....	9	20 9 46	114 42
399	394	86	....	8.9	20 10 15	117 31
207	311	57	....	7.8	20 10 35	114 19
68	239	109	....	9	20 11 18	115 6
207	311	58	....	8.9	20 11 21	113 10
68	239	110	B.A.C. 6982	7	20 11 23	115 40
207	311	59	....	9	20 11 41	113 13
68	239	111	....	8	20 12 2	115 39
72	241	69	....	8.9	20 12 15	116 36
68	239	112	....	9	20 12 42	115 45
70	240	88	....	9	20 12 53	114 46
68	239	113	....	9	20 13 3	116 20

Page.	Zone.	No.	Name of Star.	Mag.	R.A.	N.P.D.
					h m s	° ′
207	311	60	....	8.9	20 13 8	113 14
70	240	89	....	7	20 13 13	113 55
68	239	114	....	9	20 13 31	116 38
68	239	115	....	9	20 14 4	116 37
207	311	62	....	8.9	20 15 34	114 37
207	311	64	....	7.8	20 16 2	113 55
68	239	119	....	9	20 16 16	114 59
68	239	118	....	8.9	20 16 24	114 43
68	239	120	....	9	20 16 25	115 0
207	311	65	....	8.9	20 17 5	113 56
68	239	121	....	8.9	20 18 2	115 0
68	239	122	....	8.9	20 18 46	115 5
70	240	95	....	9	20 18 57	114 49

New Variable Star. By Norman Pogson, Esq.

(*Communicated by J. G. Barclay, Esq.*)

A small but rather remarkable star, probably similar in its nature to *U Geminorum*, was, on May 19th, proved to be variable, with the large refractor of the Leyton Observatory, constructed for J. G. Barclay, Esq., by Mr. Cooke of York. The star in question is 30′ n. p. 11^{s} of *θ Libræ*, and was first seen on May 3d with Dr. Lee's Smythian telescope, while looking over my chart of hour 15 at home. It then shone as a star of the 9·5 magnitude; and, on the supposition of its being a new planet, was forthwith compared with the star A Z 205·58, with the aid of the ring-micrometer, and a half-seconds' sidereal chronometer, for the loan of which I am indebted to the Royal Geographical Society. Clouds rendered the observation nearly worthless as a position, but sufficient comparisons were obtained to show that it was no planet. It was accordingly entered upon my chart without further remark; but on May 19th, when examined with the Leyton equatoreal, had so sensibly diminished as at once to establish its variability, being then not brighter than a star of the 11th magnitude. On June 1st no trace of it was discernible in the Smythian telescope, when neighbouring twelfth magnitudes were well seen. As I swept over the same chart with considerable care on April 18th, I feel assured that it must then have been at least below the 11th magnitude. The whole duration of visibility has therefore passed in a month or less.

The only additional information which I am able to furnish "decisively," is that on April 18th, 1855, when this part of my

chart was completed; also on April 20th, 1857, when I swept over it at Hartwell with the principal refractor of Dr. Lee's observatory, no star so bright as the twelfth magnitude occupied this position. The part of the heavens has, however, been under regular examination during the spring months of 1856 and 1857, but no star has on any occasion been recorded in the place of the new variable.

The approximate co-ordinates, reduced to 1860, are, Right Ascension, $15^h\ 45^m\ 40^s$, and South Declination, $15°\ 49'$. Agreeably to Professor Argelander's nomenclature, the proper designation will be *R Libræ*, this being the first variable yet found in that constellation.

South Parade, Oxford, June 9th, 1858.

Results of the Observations of Small Planets, made at the Royal Observatory, Greenwich, in the month of May, 1858.

(*Communicated by the Astronomer Royal.*)

Hebe.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, May 3 12 44 16·1	15 30 44·23	85 35 37·78
5 12 34 39·0	15 28 58·73	85 25 36·75
6 12 29 49·5	15 28 4·97	85 20 50·31
7 12 24 59·5	15 27 10·72	85 16 15·34
8 12 20 9·3	15 26 16·28	85 11 50·16
18 11 31 40·5	15 17 5·13	84 39 2·45
19 11 26 50·4	15 16 10·71	84 36 55·85
25 10 57 57·3	15 10 52·33	84 29 9·26

Massilia.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
h m s	h m s	° ′ ″
1858, May 3 10 58 31·4	13 44 42·16	100 40 58·63
4 10 53 45·8	13 43 52·40	100 36 2·17
6 10 44 18·0	13 42 16·10	100 26 21·84
7 10 39 35·5	13 41 29·45	100 21 41·95
20 9 40 18·2	13 33 17·58	99 31 29·58
22 9 31 32·7	13 32 23·77	99 25 44·38
25 9 18 35·1	13 31 13·70	99 18 25·50

Melpomene.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
	h m s	° ′ ″
1858, May 7	8 37 18·3	11 38 52·14	78 34 44·53

Psyche.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
1858, May 3	11 41 33·6	14 27 51·48	100 15 37·16
4	11 36 51·0	14 27 4·67	100 11 36·16
6	11 27 26·3	14 25 31·51	100 3 35·95
7	11 22 44·1	14 24 45·13	99 59 40·89
8	11 18 2·3	14 23 59·10	99 55 50·91

Thalia.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
1858, May 3	10 22 42·7	13 8 47·65	85 15 11·60
4	10 18 7·4	13 8 8·15	85 18 3·84
6	10 9 1·6	13 6 53·90	85 24 17·85
7	10 4 30·5	13 6 18·60	85 27 44·44

Amphitrite.

Mean Solar Time of Observation.	Apparent R.A.	Apparent N.P.D.
	h m s	h m s	° ′ ″
1858, May 3	9 8 45·7	11 54 38·48	92 26 57·64
6	8 56 6·1	11 53 46·48	92 24 44·27
7	8 51 55·8	11 53 32·07	92 24 20·45

Note on the Approaching Conjunction of Venus with the Sun.
By Prof. Mädler.

"During the present year there will be a very close conjunction of *Venus* with the sun, and I wish that the Royal Astronomical Society may direct its attention to this phenomenon. On May, 1849, I could observe *Venus* to within a distance of $1\frac{1}{2}^{\circ}$ from the sun, so that, on the day of conjunction, I saw the planet in the morning as an evening-star and in the evening as a morn-

ing-star. My observations gave me for the horizontal refraction at the surface of *Venus* a constant = 43″·7. It seems of the greatest importance that this rare opportunity should not be neglected, and that the conjunction of Dec. 13 ($16^h\ 56^m$ Berlin Solar Time) with an approximation of the centres of *Venus* and the Sun = 1° 4′, may serve to check the determination in 1849. But at Dorpat the planet's culmination will take place only 9° above the horizon, and this position is quite unfit for such a delicate observation. Fortunately, many well-armed observatories in different parts of our globe are far better situated for observing this phenomenon; and I consider it proper to give an account of he apparatus I used in 1849.

"A cylinder of thick pap, blackened on the interior surface, and at one side prolonged about eight feet beyond the opposite side, was applied at the object end, and the prolonged part turned against the sun, while *Venus* rested visible to the observer. With this precaution, all direct or indirect radiation from the sun on the object-glass could be avoided, and although the crescent was extremely faint, I could observe it in a tranquil and blue sky, without the aid of a dark glass.

"I request the aid of the Astronomical Society in obtaining observations of this conjunction from the Observatories of Poonah, Trevandrum, the Cape, and other well-situated points.

"*Dorpat, May* 28, 1858."

Major Lang observed the solar eclipse of March 14–15, 1858, at St. Croix, West Indies, with a 46-inch achromatic telescope, using an excellent helioscopic eye-piece, magnifying power about 40, in which the sun's image appeared like a piece of white paper, and equally easy for the eye to look at.

The sun rose eclipsed, a magnificent crescent. At the conclusion there was not a cloud to interrupt his observation, which took place March 14, $19^h\ 38^m\ 38^s{\cdot}7$ mean time at his position, which long since he had assumed as determined to be in 17° 44′ 32″ north latitude, longitude 64° 41′ west, or in time $4^h\ 18^m\ 44^s$ west from Greenwich.

Several minutes before the conclusion of the eclipse, the pointed cusps of the sun appeared of an intense whiteness, and to his eye with a very minute waving glow about them, and which intense whiteness and waving glow accompanied the cusps to the end of the eclipse, when a momentary confusion took place: nothing of Baily's beads was noticed.

Captain Noble exhibited three drawings of a congeries of solar spots observed by him on the 8th, 9th, and 10th of June. A comparison of the appearance presented by the principal group

on the first two days of observation seemed to indicate that a considerable change had occurred during the intermediate interval. The author calls attention to the fact that the penumbra is narrow, washy, and ill-defined towards the sun's limb, while it is broader and comparatively dark on its inner edge, an effect directly opposed to the popular explanation of the nature of these spots. He gives the following description of an apparatus which he employs for obtaining a general view of the sun. The principal part is a cone of cardboard of 1 foot in height and 6 inches in diameter at the base, which is truncated at a point where the diameter equals that of the eye end of the equatoreal. A wooden circle covered with black velvet clasps the eye-piece. At the base of the cone is a disk of plaster of Paris (carefully smoothed while wet upon a sheet of plate-glass) held up by a cardboard one. In one side of the cone a little sort of door is cut to look through: the mode of using this will be apparent to every one. The telescope being directed to the sun, the cone is slipped over the eye-piece, and the solar image is of course projected on the plaster disk, and is viewed through the hole or door in the side of the cone. It is, perhaps, unnecessary to add, that the cone is densely blackened inside. The view of heliographic detail thus obtained is beautiful in the extreme; the mottling of the sun's disk, the faculæ, and the spots, are wonderfully shown. Of course the whole aperture of the telescope is employed.

The following letter relative to the instruments of the Lucknow Observatory has been received from Lieutenant Tennant, of the Bengal Engineers, First Assistant of the Great Indian Survey:—

"I believe I was the only member of the Society present at the capture and occupation of Lucknow, and I think possibly some account of what has been the fate of the observatory and instruments may, though removing almost all hope of the latter ever again being found, be not uninteresting.

"The building I visited and found in good order except that the doors and windows had been removed, the dome of the equatoreal had been perforated by two or three round shot, but the building itself was unhurt. The pillars were undefaced, and even the meridian pillars close to the building, but external were in good order.

"The screws fastening the metal of the instruments to the stone seemed to have been carefully extracted, and for a short time I indulged hopes that some one had preserved them as the King's property. I learnt, however, that when General Havelock relieved the garrison, most of the portable parts were removed and carried in as prize, and from their weight were left behind when Sir Colin Campbell took out the garrisons.

"It is beyond hope that anything in the shape of an instrument

can now remain unfound in anything like a perfect state. I purpose, however, endeavouring to get rewards offered for the object-glasses and telescopes, and the magnets of the magnetic apparatus. I have only seen two telescopes found at Lucknow, which appeared possibly to have been the property of the Observatory, viz., one 60-inch focus and $2\frac{1}{4}$ aperture, and a 30-inch telescope with 2-inch aperture. Each, however, was separated from all but one eye-piece, and I did not think them worth purchase at the prices wanted for them.

"It must be a matter of regret that such valuable instruments should have perished without rendering any results to science. The larger part of the records is known to have been destroyed by insects long before the mutiny, and my inquiries failed in procuring information of any but a portion of a book of Meteorological Records, which was in the hands of the Royal Engineers."

It is well known to astronomers that the proper motion of *Sirius* is variable. This fact has been conclusively established by the researches of M. Bessel and M. Peters on the observed right ascensions of the star. M. Laugier, in a very interesting paper recently communicated to the Academy of Sciences of Paris, has shown that the observations of the star in north polar distance indicate a similar variability of proper motion. The basis of his investigation consists of fourteen epochs of north polar distance derived from the most trustworthy observations of the star, made between the years 1690 and 1852. Assuming that the proper motion may be represented by two terms, one proportional to the time and the other proportional to the square of the time, M. Laugier finds, as the definitive result of his researches, that the proper motion M of *Sirius* in north polar distance, during the period of 162 years, included between 1690 and 1852, may be represented by the formula,—

$$M = 1''{\cdot}068774\, t - 0''{\cdot}001229856\, t^2$$

in which t signifies the number of years that have elapsed since 1852; and in which, consequently, for any epoch anterior to 1852, t will be negative.

From this formula he deduces the following values of the proper motion of *Sirius* in north polar distance for the corresponding epochs: —

	Years.	Proper Motion.
1690–91,	$t = -161{\cdot}5$,	$1''{\cdot}466 \pm 0''{\cdot}05$
1755–56,	$t = -96{\cdot}5$,	$1''{\cdot}306 \pm 0''{\cdot}03$
1815–16,	$t = -36{\cdot}5$,	$1''{\cdot}159 \pm 0''{\cdot}03$
1858–59,	$t = +6{\cdot}5$,	$1''{\cdot}053 \pm 0''{\cdot}02$

M. Laugier concludes his paper with assigning the following values of the mean north polar distance of the star for the years 1855, 1860, 1865, 1870, and 1875 :—

Year.	Mean North Polar Distance, January 1.
1855	106° 31′ 11″·835
1860	31 34·037
1865	31 56·271
1870	32 18·540
1875	106 32 40·841

It will be in the recollection of the Fellows of the Society that a few years ago an expedition, under the superintendence of Lieut. Gilliss, was despatched to Chile by the Government of the United States, for the purpose of making observations of *Venus* and *Mars*, to be employed in obtaining a new determination of the solar parallax. Upon the return of the expedition, the observations were placed in the hands of Dr. Gould, with a view to their thorough discussion; and it is understood that for some time past the astronomer just named has been engaged in that task. From the following passage extracted from the *National Intelligencer* of Feb. 23, it would appear that he has finally arrived at the termination of his labours:—

"The result obtained by him for the sun's equatoreal horizontal parallax is 8″·4950 or 0″·0762 less than the value commonly adopted, and he concludes that we may assume with advantage 8″·5000."

Dr. Winnecke has recently found that the star Lalande No. 21185, which Prof. Argelander had discovered to have an annual proper motion of 4″·734, has a parallax amounting to 0″·511.* His researches were founded on a series of his own observations with the heliometer of the distance of the star from two other small stars in its vicinity. The following are the approximate co-ordinates of the two stars of comparison *a* and *b*:—

a	7.8 mag.,	Distance 869″·0,	Pos. Angle 317° 25′·6
b	8 mag.,	Distance 1622″·2,	Pos. Angle 139 24·1

The Rev. T. W. Webb states that on May 19 he had the pleasure of witnessing the occultation of *Regulus* by the

* *Ast. Nach.* No. 1147.

moon, with Mr. Slater's great achromatic, now being exhibited in the New Road. This instrument, which is mounted on a polar axis, and driven by an ingenious application of water power, is 20 feet in focal length, with an aperture of 14·77 inches. The adjustment of the object-glass was not completed on the evening in question, and the air was not very favourable, so that a power of only about 180 was employed; but with this there was very fair definition. The focus was adjusted upon the star, which was extinguished instantaneously: its disappearance could not have occupied a quarter of a second. The moon's dark limb, though perceived by others, was not distinct enough to my eye to exhibit any projection of the star, had it occurred. *Saturn* was so much enveloped in smoke as to admit of only a glimpse or two, but those were very distinct. Mr. Webb was informed that a few evenings previously Encke's subdivision upon the ring A had been clearly seen.

Elements of Europa (*Planet* ㉜). By Dr. Schultz.

Epoch 1858, March 3·45645 Berlin M.T.

	°	′	″	
M	45	25	6·1	
ϖ	102	10	35·4	Mean Equinox, Jan. 0
Ω	129	55	35·5	
i	7	23	48·7	
φ	5	52	11·5	
Log μ	2·813339			
μ	650·6371			
Log a	0·491112			

Accompanying these elements was an ephemeris of the planet extending from May 8 to June 29.

RECENT PUBLICATIONS.

On the relative Intensity of the Heat and Light of the Sun upon different Latitudes of the Earth. By L. W. Meech, A.M. (*Smithsonian Contribution to Knowledge*, Vol. IX. Washington. 4to. 1857.)

This elaborate paper is divided into nine sections.

Section I. *Irradiated Surface upon the Planets.*—In this section the author investigates the formulæ for calculating the

breadth of the zone upon the surface of each planet, which, in addition to a hemisphere, is illuminated by the solar rays. He then applies his formulæ to the various planets, and embodies the results in a table of considerable interest.

Section II. *Law of the Sun's Intensity upon the Planets in relation to their Orbits.* In this section the author investigates a formula for determining the intensity of the solar rays upon a planet depending on the variable motion of the latter in an elliptic orbit. A table is given exhibiting the results of calculation for each planet.

Section III. treats of the law of the sun's intensity at any instant during the day; in Section IV. the author determines the sun's hourly and diurnal intensity; Section V. contains the investigation of a formula for ascertaining the sun's annual intensity upon any latitude of the earth; Section VI. is devoted to an inquiry into the average annual intensity of the sun upon a part or whole of the earth's surface.

In Section VII. the author considers the effect of secular change of the sun's intensity. We quote the following passage:—

"In the *Connaissance des Temps* for 1843, Le Verrier has exhibited the secular values of most of the elements of the planetary orbits during a hundred thousand years before and after Jan. 1, 1800. The excentricity of the earth's orbit in the present time being ·0168, the value 100,000 years ago, and the greatest in that interval was ·0473. Substituting these in the preceding expression,* we find that the sun's annual intensity at the former epoch was greater than at present by one-thousandth part. Now this fraction of 365·24 days counting the days at twelve hours each in respect to solar illumination, *amounts to between four and five hours of sunshine in a year;* and by so small a quantity only has the sun's annual intensity, during a hundred thousand years past, ever exceeded the yearly value at the present time. Nor can it depart from its present annual value by more than the equivalent of five hours of average sunshine in a year for 100,000 years to come.

"The superior and ultimate limit given by Le Verrier to which the excentricity of the earth's orbit may have approached at some very remote but unknown period or periods is ·0777. At such epoch the annual intensity is computed as before to have exceeded the intensity of the present by *thirteen hours* of sunshine in a year. On the other hand, the inferior limit of excentricity being near to zero indicates only *four minutes* of average sunshine in a year less than the present annual amount. Between these

* The author here refers to the expression $\sqrt{\frac{1-e^2}{1-e'^2}}$, where e represents the present excentricity of the terrestrial orbit, and e' the excentricity corresponding to any epoch whether past or future.

two extreme limits all annual variations of the solar intensity, whether past or future, must be included even from the primitive antediluvian era, when the sun was placed in his present relation to the earth."

In Section VIII. the author considers the subject of local and climatic changes of the sun's intensity. In the ninth and concluding section he investigates the diurnal and annual duration of sunlight and twilight.

The author has appended to his paper an elaborate series of curve lines illustrative of the results at which he has arrived.

Astronomical Observations made at the Observatory of Cambridge. By the Rev. James Challis, M.A., F.R.S., Plumian Professor of Astronomy and Experimental Philosophy in the University of Cambridge, and late Fellow of Trinity College. Vol. XVIII. for the Years 1849, 1850 and 1851, 4to. Cambridge, 1857, pp. 425.

In an Introduction, extending to seventy-five pages, Prof. Challis explains the processes for reducing the observations, and the formulæ and constants used for that purpose. For a description of the instruments and methods of observing he refers the reader to the volumes of Observations of 1838 and previous years.

The subject-matter of this volume is confined to observations with the transit and the mural circle, and occultations of stars by the moon. The observations of planets and comets made with the Northumberland equatoreal during the three years to which the volume refers are reserved for separate publication.

The observations for each year are followed by catalogues of the concluded mean right ascensions and north-polar distances of the stars observed during the year; horizontal and vertical measures of the diameter of the sun and moon compared with the tabular diameters; observed places of the sun, moon, and certain planets, and their comparison with the calculated places; and, lastly, the details of the observed occultations and the calculation of the coefficients of the resulting equations of condition for correcting the elements of the moon's orbit.

The number of stars contained in the Catalogue for 1849 amounts to 1203; the Catalogue for 1850 contains 911 stars; the Catalogue for 1851, 813 stars. The volume also contains a catalogue of approximate right ascensions and north-polar distances of zodiacal stars observed with the mural circle in the year 1846. The number of stars observed amounts to 426.

Report of the Astronomer Royal to the Board of Visitors of the Royal Observatory, Greenwich, Read at the Annual Visitation of the Royal Observatory, 1858, *June* 5.

The following are a few extracts from this Report:—

"The new south-east dome has been constructed in exact conformity with the plan explained to the Visitors at their last meeting, and is in nearly all respects ready for reception of the equatoreal. Its place is at a very small distance from the south-eastern corner of the Record-Room, where there was exactly space enough to allow three passages around it, (the principal passage to the Magnetic Ground, a passage between the Dome and the Record-Room, and a passage on the edge of the Garden), which it was indispensably necessary to preserve. The stove, with underground draft, answers well for warming the two lower stories. The Drum-dome, whose external diameter is 32 feet, is constructed with vertical standards upon a horizontal curb, tied by diagonal iron-hooping, covered with very thin boarding, and then covered with zinc. In planning this frame, I omitted to notice that a considerable stress is put upon the two principal standards which form the sides of the vertical shutter opening, and between which there can be no diagonal tie, and that in consequence there would be a sensible bending of the jointed curb when one of these standards should bear immediately upon one of the cannon-balls. A long piece of stiff iron curb, passing under the feet of these two standards and for some distance on both sides of them, is prepared, and is at the Observatory; its mounting is deferred for convenience only. I anticipate that it will entirely remedy the inconvenience that I have mentioned. The rack for motion of the dome is fixed to the wall; the machinery which acts on it is carried by the dome, and the person who turns the winch to move the dome is always on the side opposite to the shutter-opening, and therefore sees the object to which the telescope can be directed. The machinery for opening the two shutters is on the same side as the shutter-opening; the jointed rack for the vertical shutter, and the single rack and counterpoise for the horizontal roof-shutter, answer very well. A misunderstanding of a draftsman, which was not discovered till it was too late to remedy it, has left less room between the great north iron support of the equatoreal and the ring of the curb than I designed, and in consequence the winches of the dome and shutter mechanism are compressed more than I could wish. I have not yet arranged an apparatus for fixing the dome, to prevent it from receiving an oscillation from the action of the wind. Other points of interest will be best seen in the building itself. . . . .

"*Astronomical Instruments.*—The transit-circle is in good order. The fault of insulation of the galvanic part, to which I alluded in the last Report, was speedily remedied. A small change has lately been made in the western pier which carries the micro-

scopes of this kind. The Visitors are aware that the illumination of those parts of the limb which are under view of the microscopes is effected by a single central lamp, on the external side of the pier, shining through holes which are perforated through the pier; and that in each hole there is a lens for intensifying the light upon the limb, and that the accurate reflection of the light from the limb up the tube of the microscope will depend in some measure on the position of the lens, and therefore a power of adjusting the lens is desirable. The only way of adjusting the illuminating lenses which had been used in practice, was to force wedges of different thicknesses between the sides of the brass tubes containing the lenses and the sides of the holes in the stone pier. The change now made is the following:—The interior of the stone pier is cut, to a small distance beyond the circle of illuminating-holes, into the form of a concave spherical surface of which the lamp is the centre. To this surface of the stone are fixed concave brass plates, properly perforated in correspondence with the holes of the stone, and upon these the brass rings which carry the illuminating lenses are fixed, by thumb-screws passing through large holes that allow a considerable range of adjustment. I trust that we shall now make the appearance of the divisions under the microscopes unexceptionably good.

"Mr. Simms, and Messrs. Ransomes and Sims, are at present engaged in preparing a transit-circle for the observatory of San Fernando, near Cadiz, similar to that at Greenwich (or rather to that at the Cape of Good Hope). Artificial stones of Portland cement, bearing the proper perforations, have been prepared here for the Microscope Pier. The blocks are shaped for the reception of concave brass plates for adjustment of the illuminating lenses, in the manner which I have just described. . . . .

"For the new south-east equatoreal, the object-glass was furnished by Messrs. Merz and Son in the summer of last year, and I made various trials of it in a temporary tube carried by the temporary mounting which I had provided, and finally I was well satisfied with it. I cannot yet say that I have certainly divided the small star of *γ Andromedæ;* but, for such a test, a combination of favourable circumstances is required. From what I have seen, I have no doubt of its proving a first-rate object-glass. The north support of the polar axis (wanting the small part at the top, which immediately supports the pivot) and the adjustable parts of the south support (also wanting some parts) are mounted in their places. No other parts of the instrument are here, but almost the whole of the work is in Messrs. Ransomes and Sims' workshops very nearly ready. . . . .

"*Astronomical Observations.*—Our principal attention, as heretofore, has been fixed upon those objects which may be considered fundamental. The meridional system is carefully preserved. In regard to stars observed on the meridian, the greater part of the observations have been devoted to the large clock-catalogue, of which the stars are never allowed (if possible) to pass unobserved in any year. Some observations, however, have been given to

moon-culminators, occulted stars, stars favourable for zenith-points, stars with *Mars* and with comets, stars with large proper motion, low stars for refraction, variable stars, stars used for the longitude of Edinburgh, and stars observed at the request of private astronomers. In regard to moveable bodies observed on the meridian, the moon is never omitted; the sun and planets are omitted on Sundays; the planets also are omitted after 15^h, unless when the moon passes after 15^h. The chronographic method is exclusively used for transits of planets and of stars not very close to the pole (unless the galvanic apparatus is deranged).

"The following is the tale of Meridional Observations from 1857, May 23, to 1858, May 21:—

Transits (two limbs, or methods of observation being counted at two)	5024
Pairs of observations of collimators with the transit-telescope	309
Observations of transit-wires by reflexion	304
Observations of collimator by collimator	52
Circle-observations of all kinds	4714
Observations of zenith-distance-wire by reflexion (included in the last)	293

"The system of observations for adjustment is the same as for several years past.

"The errors of graduation for every 1° of the meridian circle having been determined by the operation of last year, these have been taken as basis for determination of the errors of graduation of certain divisions in the series of arcs of $5'$. Observations have been made and reduced for determining the errors of those divisions which fall under the microscopes in observations of *Polaris*, *Polaris* S.P., and the wire by reflexion, which come into use far more frequently than any others.

"The number of double observations of γ *Draconis* with the reflex zenith tube is 109, or 218 single observations.

"With the altazimuth: the total number of observed azimuths of moon and stars is 788; of the collimator, 424. The total number of observed altitudes of the moon is 407; of stars (for time only), 4; of the collimator, 424. The complete observations of the moon, on days when her meridian passage occurred between 0^h and 1^h solar time, are 2; between 1^h and 2^h, 2; between 2^h and 3^h, 11; between 21^h and 22^h, 2; between 22^h and 23^h, 1; between 23^h and 24^h, 0. The whole number of days of complete observations of the moon is 210, or about 16·9 per lunation. The corresponding number on the meridian is 122, or about 9·8 per lunation."

The Meteorological and Physical Effects of the Solar Eclipse of March 15, 1858. By James Glaisher, Esq. F.R.S.

On the Determination of the Mean Temperature of every Day in the Year from all the Thermometrical Observations taken at the Royal Observatory, Greenwich, from the Year 1814 *to the end of* 1856.

In the first-mentioned of these pamphlets, Mr. Glaisher has collected and discussed the accounts respecting the meteorological and physical effects of the recent solar eclipse which had been forwarded to the Meteorological Society from various parts of the country. The numerical results are embodied in tables and are illustrated by curves of a highly suggestive character. The following table, exhibiting the variations of temperature during the eclipse at a number of different places, will be perused with interest:—

Place of Observation.	Limits of Temperature.	Difference.		
	° °	°		
Braemar	41·7 to 39·0	... 2·7		
Stonyhurst	44·9 to 44·1	... 0·8		
Hawarden	51·0 to 47·0	... 4·0		
Lampeter	51·0 to 48·8	... 2·2		
Wakefield	48·0 to 45·8	... 2·2	2·2	At stations north of the central line.
Manchester	45·8 to 45·1	... 0·7		
Grantham	48·2 to 45·9	... 2·3		
Birmingham	48·8 to 46·8	... 2·0		
Teignmouth	54·5 to 52·2	... 2·3		
Helston	54·0 to 51·0	... 3·0		
Peakirk	48·7 to 46·2	... 2·5		
Oundle	50·8 to 46·9	... 3·9		
Oxford	51·8 to 49·2	... 2·6	3·1	At stations on or near the central line.
Blisworth	47·0 to 45·2	... 1·8		
Swindon	51·0 to 47·0	... 4·0		
Little Bridy	50·4 to 46·7	... 3·7		
Holkham	49·7 to 44·6	... 5·1		
Norwich	50·0 to 48·0	... 2·0		
Cardington	50·2 to 47·8	... 2·4		
Royston	48·5 to 46·7	... 1·8		
Lewisham	50·4 to 48·2	... 2·2		
Greenwich	50·8 to 48·2	... 2·6	2·7	At stations south of the central line.
St. Thomas's Hospital	50·4 to 49·2	... 1·2		
Battersea	51·0 to 47·6	... 3·4		
Fairlight	48·5 to 45·5	... 3·0		
Ventnor	50·0 to 47·0	... 3·0		
Guernsey	52·0 to 48·5	... 3·5		

It will suffice merely to direct the attention of the Fellows of the Society to the second of the above pamphlets.

Beobachtungen der Kaiserlichen Universitäts Sternwarte Dorpat, herausgegeben von J. H. Mädler. Bande XIII., XIV. 4to. Dorpat, 1856.

These volumes contain a valuable collection of observations and researches in Stellar Astronomy by Prof. Mädler. The thirteenth volume is occupied chiefly with observations of double stars made with the great refractor of Dorpat between the years 1846 and 1853. The first part of the volume contains the observations made between the years 1846 and 1851. They are subdivided into four groups. The first group consists solely of stars for which orbits have been calculated. The magnitude, position-angle, and distance of each star, and also the differences between the observed and calculated co-ordinates, are duly recorded. The second group comprises stars whose binary character has not yet been ascertained. Besides the position-angles and distances, the annual variations are given, and also the differences between the latter, and the values calculated from a formula which the author has given in the previous volume of the Dorpat Observations. The third group contains micrometric measures of stars which have not hitherto offered any indications of relative motion. The fourth comprises observations of stars contained in the Pulkowa Catalogue of 1842.

The second part of the volume contains the observations made from 1851 to 1853. These are followed by a catalogue of all the stars which have been found to indicate a relative motion. Appended to this catalogue is a series of notes on several of the objects contained in it.

The volume concludes with an investigation of the orbit of *Neptune's* satellite by the late M. Augustus Struve. The materials of this investigation consist of 21 observations of the satellite in position-angle and distance made by M. Otto Struve in the years 1847 and 1848.

The fourteenth volume is devoted to an investigation of the proper motions of the fixed stars, the translation of the solar system in space, and the doctrine of a central point in the visible universe. The volume commences with a catalogue of 3222 of Bradley's stars reduced from the totality of the earlier and more recent observations to the beginning of the year 1850. These form the materials of the subsequent investigations. The catalogue is succeeded by a classification of the proper motions according to the magnitudes of the stars. The data employed in solving the problem of the motion of the solar system in space consist of

(*a*)	227	stars with an average secular proper motion of			55″·40
(*b*)	663	,,	,,	,,	15″·25
(*c*)	1273	,,	,,	,,	7″·79

Discussing these classes of stars separately, the author obtains the following values of the co-ordinates of the point towards which the solar system is travelling:—

	R.A.	Dec.	
	° ′	° ′	
(*a*)	262 8·8	+ 39 25·2	for 1800
(*b*)	261 14·4	37 53·6	
(*c*)	261 32·2	+ 42 21·9	

Hence, taking into consideration the number of stars in each class, he finds the definitive values of the co-ordinates to be,—

R.A.	Dec.
261° 31′·8	+ 39° 53′·9

It will be found that this result presents a satisfactory agreement with the various determinations of the same point arrived at by previous inquirers.

This investigation is followed by a table exhibiting the differences between the direction of the observed motion of each star, and the direction calculated on the supposition of the motion of the star being solely an apparent effect due to the motion of the solar system in space. From the problem of the motion of the solar system in space, the author passes to a consideration of the centre of gravity of the system of fixed stars. A former investigation had induced him to fix this point in the *Pleiades*. The researches contained in the volume now before us appear to him to confirm the result obtained by him on that occasion.

In the Catalogue of Stars inserted at the beginning of the volume, the right ascensions are expressed in space. At the close of the researches above mentioned, the author gives the right ascensions in time. The volume concludes with a statement of observations with a transit instrument placed in the prime vertical, made by M. Wagner at Dorpat in the years 1849 and 1850, with the resulting mean places reduced to the beginning of the latter year.

Teneriffe, an Astronomer's Experiment; or, Specialities of a Residence above the Clouds. By C. Piazzi Smyth, F.R.S., S.L. and E., &c. 12mo. London. 1858.

In this interesting work Professor Smyth has given a popular account of his scientific experiences during his expedition to Teneriffe in the autumn of 1856. Of course the nature of the work precludes any detailed notice of its contents in this journal.

We shall merely remark that the letter-press is illustrated with a series of photo-stereographs, the original negatives of which were taken by Professor Smyth himself, and which are viewed with a stereoscopic apparatus constructed so as to fold up in a case like a map.

In the preface to his work, Professor Smyth states that he has communicated to the Royal Society the results of his strictly scientific labours during his residence at Teneriffe. We may therefore expect that ere long they will be in the hands of the public.

Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1856; *under the direction of George Biddell Airy, Esq., M.A., Astronomer Royal.* Published by order of the Board of Admiralty. 4to. London, 1858.

This annual volume is too well known to astronomers to require any detailed notice of its contents. Among the results of the observations we find a catalogue of the concluded mean right ascensions and north polar distances of 533 stars reduced to the beginning of the year. The objects of this catalogue consist mainly of stars which have been observed in former years. In the case of all new stars the requisite constants for reduction have been computed and inserted at the end of the catalogue.

An appendix to the volume contains a description of the galvanic chronographic apparatus, with appropriate engravings. The volume concludes with the report of the Astronomer Royal to the Board of Visitors, read at the Annual Visitation, 1857, June 6.

Annuaire des Marées des Côtes de France, pour l'an 1857, *publié au Depôt de la Marine.* Par A. M. R. Chazallon, Ingenieur-Hydrographe de la Marine. 18mo. Paris, 1856.

This little volume, besides giving the times of high water at all the French ports, contains much useful information of a more general character, relative to physical geography, chronology, and other miscellaneous subjects.

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